Net Environmental Benefit Analysis (NEBA) Decision-Making Tool

Developing Consensus for Environmental Decision-Making In Emergency Response

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Net Environmental Benefit Analysis (NEBA)

Resource management tool designed to improve the quality and results of environmental decision-making

Net Environmental Benefit Analysis (NEBA)

- Consensus-based process
- Brings natural resource science together with the reality of resource management decision-making
- Provides a means for:
  - Considering proposed environmental actions
  - Comparing and contrasting trade-offs of those actions
  - Prioritizing those outcomes through risk-ranking

Net Environmental Benefit Analysis (NEBA)

When used by Natural Resource Scientists and resource management decision-makers, the NEBA process creates an open, honest dialogue of the capabilities and limitations inherent in resource management and the decision-making tradeoffs faced by resource managers today.

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Net Environmental Benefit Analysis (NEBA)

- NEBA has been used extensively in EPA Region 9 in emergency planning to assist decision-making during a response.
- Environmental issues often too complex to work through in the time-frame of an emergency.
- NEBA helps to break down the complex issues involved, enabling decision-makers to incorporate environmental concerns into response quickly without sacrificing good science.

Net Environmental Benefit Analysis (NEBA) Overview

- Background and Significance
- Realities of an Oil Spill – The NEBA/Consensus Building process
- Ecological Risk Assessment (ERA) Process - modifications for spill response
- Accomplishing a NEBA
- Understanding and Explaining the limits of the Analysis
- Questions and Answers

Why NEBA? - Background and Significance

- Regional Response Team IX – California Coast
- National Contingency Plan (NCP) – Spill Response
- The California Coast in 1998 – Science competing with ‘Myth and Innuendo’ for prominence in Spill Response Decision-Making
- San Francisco Bay Area Committee - San Francisco Bay and Delta ERA sponsored by RRT-IX members CA DFG OSPR, USCG, others

Why NEBA? - Background and Significance

- SF Bay ERA – Not an ERA; an Awakening
- Open/Honest Communication
- Natural Resource Management and Reality
- Spill Response Expectations and Reality
- Science, Empathy and Decision-Making

Why NEBA? - Background and Significance

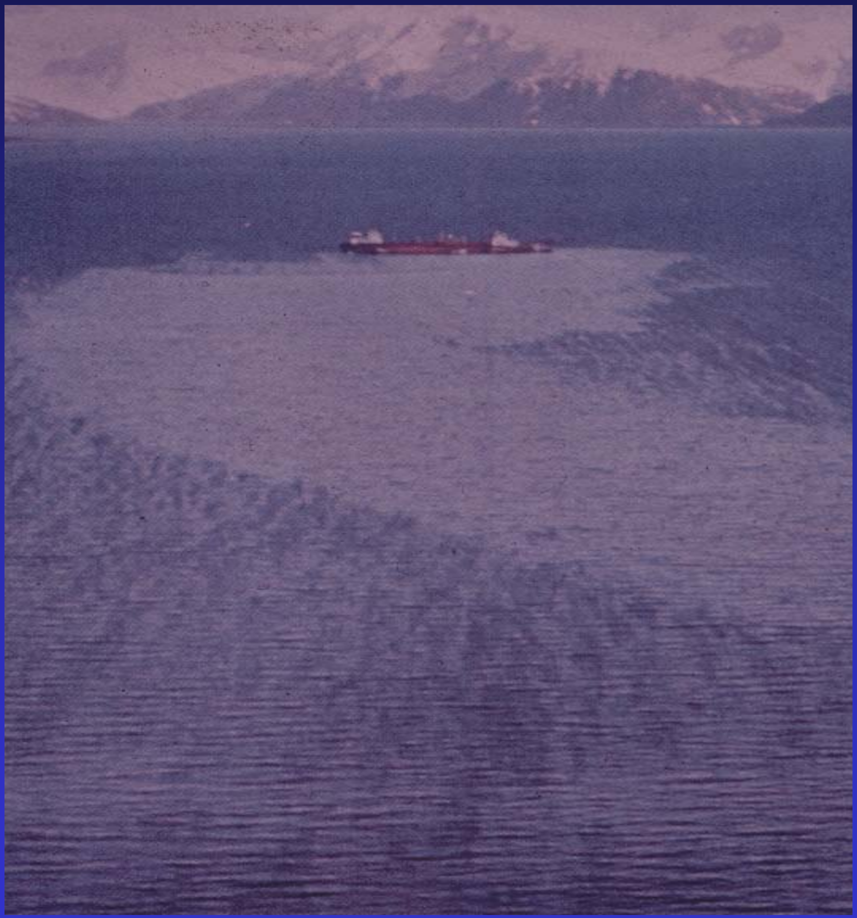
- SF Bay ERA – The Consensus Analysis Process was as much the Product as the ERA Relative Risk Summary. Could the RRT replicate it for daily use?

- If you want consensus during a meeting (spill), it needs to be developed beforehand (NEBA).

- Creating a Culture – Replacing myth and innuendo with Science, Dialogue and Consensus (NEBA) along the entire California Coast.

Realities of an Oil Spill

- Once oil is spilled, there will be injury to the environment (Can't put Humpty-Dumpty back together again).
- No amount of cleanup will remove all the oil from the environment.



Realities of an Oil Spill

- Question becomes how to minimize the injury, not that injury can be avoided.
- Need to look at short-term vs long-term impacts with regards to habitat and species at risk.

Realities of an Oil Spill

- All decisions associated with spill response have inherent trade-offs.
  - Mechanical
  - Chemical Counter-measures
  - In-Situ Burning
  - No Response

- Thus, want as many tools in the tool box as possible for use in an emergency situation

Goals of Oil Spill Response

- Protect human life
- Prevent additional or continuing loss of oil
- Prevent or mitigate environmental damage
  - Keep oil away from sensitive habitats
  - If oil contacts sensitive habitats, focus on clean up techniques which enhance recovery
- It can be difficult to achieve consensus among stakeholders on what the damage is likely to be and the best ways to avoid or minimize it

What Causes this Lack of Consensus?

- Secondary Issues:
  - Missing scientific information
  - Misleading or inconsistent information
  - Inadequate communication and information dissemination
- Primary issue:
  - Differences in the ecological reference framework used by the various stakeholders

- Issues seems to be an outgrowth of the way we manage resources

Conflicts can arise regarding:

- Likely impacts
- Resource Priorities for protection
- Best ways to minimize damage and enhance recovery
- Tradeoffs between the results of one action V.S. another
- How clean is clean?

Risk-Based Analyses

- A risk-based approach is implicit in response planning
- There are different Risk Analysis Frameworks, and they effect the outcome
  - Absolute risk
  - Incremental risk
  - Comparative risk

Use of a Comparative Risk Framework

- Decisions are contingent upon determining how all available response options can be used to minimize damage and encourage recovery to the ecosystem as a whole

- Selection of specific response options within a geographic area are dependent upon the nature of the spill (hazard), the resources you want to protect (endpoint), the route of exposure (pathway) and how you want to protect them

- Selecting the resources to be protected is based on evaluating the risk to each habitat and its species in comparison to all of the others

Fundamentals of Ecological Risk Assessment (ERA)

- ERA is a process to evaluate possible ecological consequences of a disturbance.
- ERA emphasizes the comparison of exposure stressors with an ecological effect. (e.g., population disruption, change in community structure or function, etc)
- This is done quantitatively as much as possible and includes an estimation of the probability that an undesirable outcome will occur.

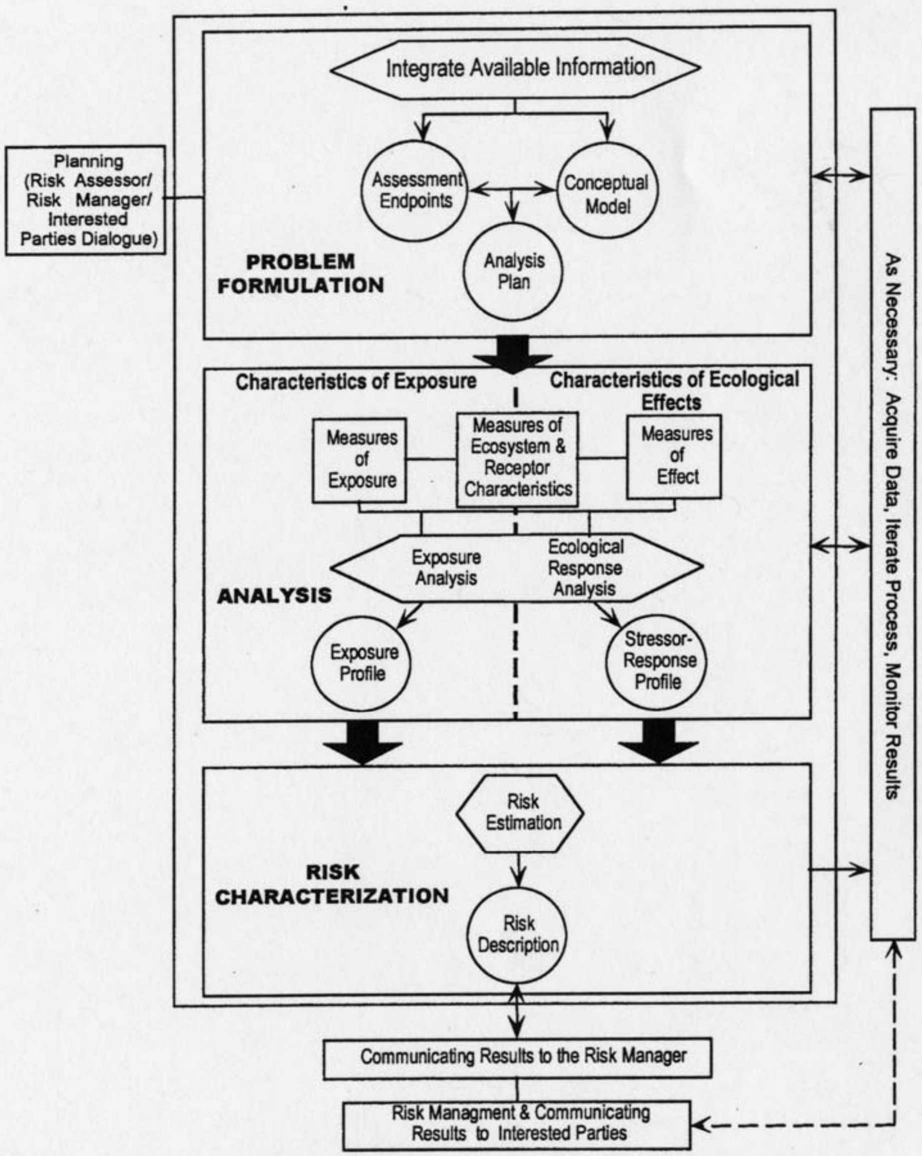


Figure 2-2: The Ecological Risk Assessment Framework (USEPA, 1998).

Ecological Risk Assessment process utilized by EPA

- Problem Formulation
- Data Analysis
- Risk Characterization

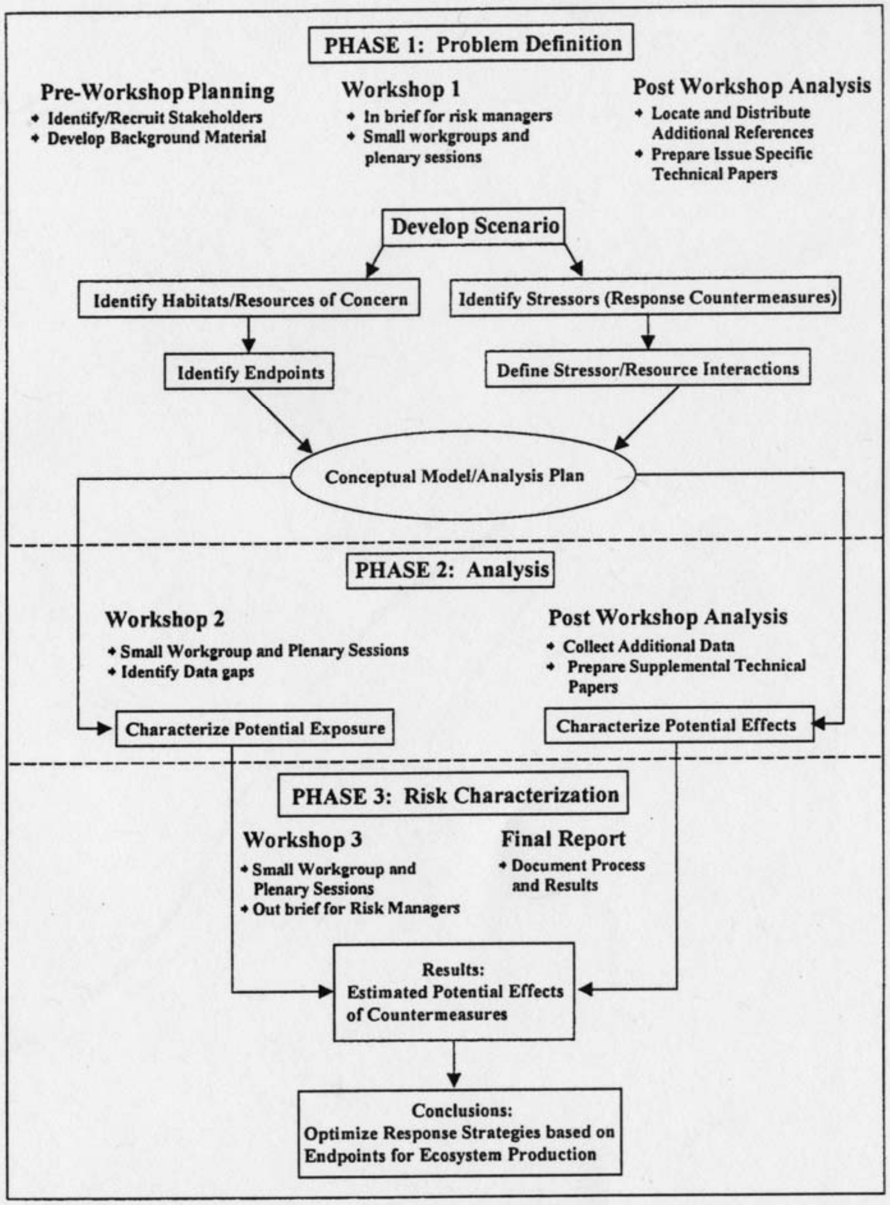


Figure 2-3: Ecological Risk Assessment Strategy Presented to Workshop Participants.

Ecological Risk Assessment process adopted for use in California ACP Processes.

- **Problem Definition and Scenario Development**
  - •ID stressors and define interaction with resources
  - •ID endpoints
  - •ID habitats/resources of concern
- **Data Analysis**
- **Risk Characterization**

Problem Formulation

(Some steps are completed in advance of the workshop)

- Prepare scenario for analysis
- Identify resources of concern and associated assessment thresholds
- Prepare a conceptual matrix to guide the subsequent analysis
- Develop an analysis plan

Analytical Phase

- Characterize exposure
- Relate exposure to ecological concerns
  - Relate to each response option
  - ‘Natural Recovery’ baseline
- Determine relative risk

Risk Characterization

- Participants
  - Interpret the results
  - Agree on impacts and critical resource issues
  - Identify options which improve conditions over the no-response baseline
  - Determine consequences for response planning and decision-making
  - Identify uncertainties and data needs

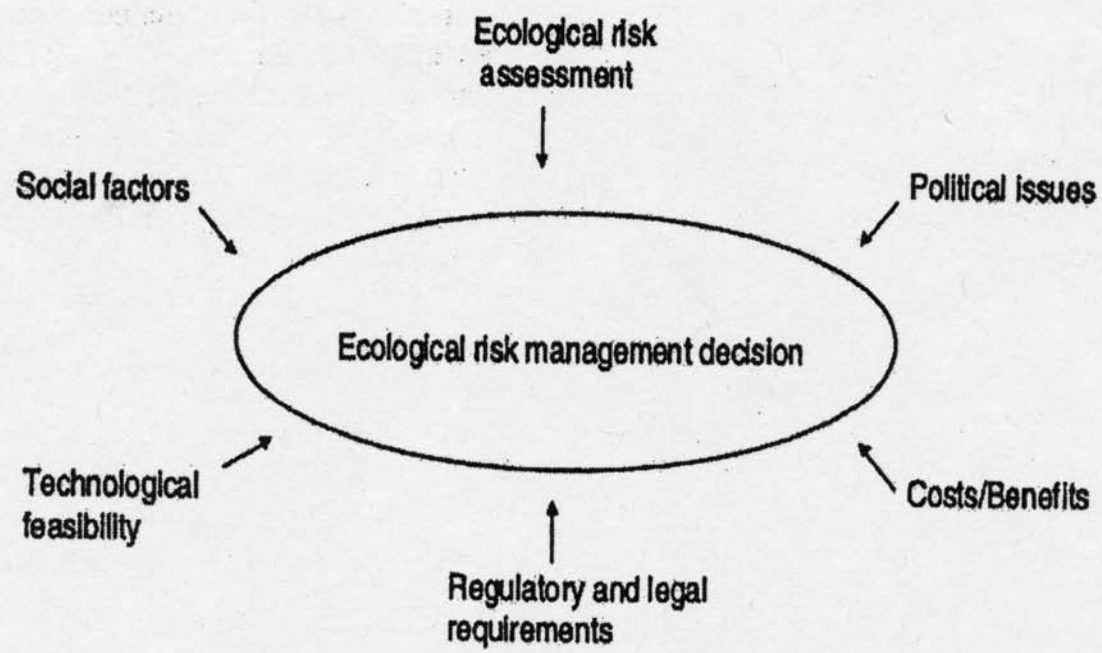


Figure 2-1: The Relationship of Ecological Risk Assessment to Management Decisions (Pittinger et. al, 1998).

An ecological risk assessment is only one input into an ecological risk management decision made in response to an oil spill.

ERA + modifications for Spill Response = NEBA

- Ecological Risk Assessment (ERA)
  - Only natural resources
- Net Environmental Benefit Analysis (NEBA)
  - Not an ERA in the formal sense of the word
  - Usually includes social and economic factors
- Also to avoid confusion with Superfund site assessments, we use the term NEBA

NEBA Process Advantages

- **Response planning often involves options that can be controversial**
- **NEBA provides a “conflict resolution” format**
- **It is also an interactive education tool that encourages full participation**
- **Helps identify critical issues for discussion**
- **Provides a framework for evaluating impacts**

Comparative Risk Assessment Analysis Methodology

- The NEBA process provides the basis for comparing and prioritizing risk.
- If every alternative presents some level of risk, then such an approach can provide the basis for choosing between alternatives.
- Goal of this risk assessment is to determine if available response options offer relative environmental improvement over natural recovery.

Realities of Spill Response Decision-Making to Keep in Mind

- Collection of spilled oil is often preferred
- It is rarely very successful
- Main objective becomes how to try to manage the impacts
- Resource and management conflicts seem inevitable
- The goal - a framework for constructive discussion and consensus decision-making.

Drivers for NEBA Development

- Help responders and resource managers understand and compare the realities and consequences of oil spills and response options – to make better and faster consensus decisions
  - Originally in nearshore or estuarine situations where dispersant and In-Situ Burning present difficult analytical issues
  - Focus on ecological “trade offs,” i.e. cross-resource comparisons
  - Find ‘common ground’ for evaluation
  - Provide a defensible methodology
  - Improve local ability to identify and implement improvements in response
- Driven by a desire for consensus about potential impacts

How is this Approach Unique?

- Science, Reality and Consensus-based
- Emphasizes potential (not actual) risk
- Planning for Pre-Approval and Response Decision-making oriented
- Education and Empathy tool
  - Mixes experienced and novice stakeholders
  - Discussion of options necessary to the analysis
  - Identifies issues of concern
  - Clarifies risks and benefits

Steps to Accomplishing a NEBA

1. **Assemble the NEBA Project Team**
2. **Identify NEBA Participants**
3. **Develop the Scenario**
4. **Define Response Options for Consideration**
5. **Estimate Fate of Oil and Potential for Exposure for Resources of Concern**
6. **Define Environmental Resources of Concern**

Steps to Accomplishing a NEBA

7. Consider all of the important Relationships and develop a conceptual model

8. Define Effects – Develop Thresholds to estimate the Sensitivity to Oil of Resources at Risk

9. Conduct the Analysis – Create a Risk-Ranking Matrix and determine the Level of Concern about potential effects

10. Prepare the Relative Risk Summary - Evaluate the Relative Risk for Response Options under consideration

11. Document the Risk Assessment and complete the Relative Risk Summary

Sample NEBA Workshop Agenda

- Workshop Objectives Review
- Results of previous workshops
- Overview of NEBA process
- Establish the baseline for the analysis
- Apply process to local scenario
- Customize resource matrix and analytical tools
- Use focus groups to evaluate relative risk
- Combine and concur on focus group results and complete comparative risk evaluation
- Concur-on and document ‘lessons learned’

Participants in the NEBA Process

- Approximately 25 to 35 individuals
- Ensure all stakeholder groups are represented
  - spill response managers
  - natural resource managers
  - subject matter experts
  - non-governmental organizations (NGOs)
- Facilitation and technical support team

Working Through the Process

- Scenario
- Response options
- Defining fate and exposure
- Resources of concern
- Defining the risk (hazards, thresholds, and exposure)
- Conducting the risk analysis

Example Scenario Summary

Location	Tolchester Channel near the Chesapeake Bay Bridge
Target	Eastern shore of the Chesapeake Bay near Rock Hall, MD
Oil Type	Number 6 Fuel Oil
Spill Size	2,000 bbls
Weather	Wind: W 12 kts (NW after 12 hrs) Water Temp: Waves: Calculated
Date or Time of Year:	Spring (May)
Time of Discharge (and Tidal Stage):	1700, slack before ebb
Nature of the Spill:	Barge collision in a restricted channel

Response Options

- Identify all response options commonly used in the study area
- Determine if you wish to consider additional response options
- Develop a description of each response option
- List the resources required (logistics) to use the option
- Define the operational limitations of the option

Response Options (cont.)

- Arrive at a consensus of the likely overall efficiency in the scenario being used
- Determine the effect of using the option on fate of the spilled oil
- List any environmental concerns (hazards) that result from using the response option

The 'No Response' Option

LIMITATIONS

- Emulsion of oil can result in volumes 2 – 3 times more than originally spilled.
- Does not address potential for significant impacts to surface water resources.
- Potential for impacts to inter-tidal and sensitive communities.
- Potential long-term impacts to surface water and inter-tidal resources.

ATTRIBUTES

- Little labor involved, mostly for monitoring.
- Only option where other forms of response are not practical.

On-Water Mechanical Recovery

LIMITATIONS

- Limited by weather and oceanographic conditions.
- Labor intensive and limited equipment availability.
- Temp. storage and long-term disposal needs
- Open-ocean recovery <15%
- Emulsion magnification
- Does not ameliorate impact potential for water surface/inter-tidal areas
- Normally, not significant improvement over no-response

ATTRIBUTES

- Removes percentage of oil from water surface.
- May be used when clouds or low ceiling prohibit dispersant use.

Chemical Dispersion

LIMITATIONS

- Not effective on all crudes and fuel oils and less than 100% effective on many crudes and fuel oils.
- Window of opportunity is usually 1 – 2 days.
- Limited by oceanographic and weather conditions.
- May result in short-term exposures (minutes to hours) to toxic levels of dispersed oil in upper few meters of water column.

ATTRIBUTES

- Capable of being used in higher wind and wave conditions than mechanical response.
- Potential to remove significant amounts of oil from water surface.
- Potential to reduce risk of spilled oil coming ashore.
- Has potential to remove large amounts of oil from water surface in relative short periods of time.

Chemical Dispersion

In-Situ Burning

- Burning can be very very effective at removing oil from the water surface.
- Generally the same limitations as mechanical cleanup because you have to contain the oil to burn it.

Data and Information Gathering

- Oil Transportation, fates and behavior of surface slick and dispersed-oil plume.
- Resource assessment: identification of distribution/locations of resources within each habitat.
- ‘Effects data’ on the hazards relative to endpoints and resources identified in model. (including toxicity/physical effects of the stressors relative to resources of concern)

Oil Budgets

- Can be prepared using calculations based on data from NOAA ADIOS model results
- Budgets estimate oil volume over time as a result of natural processes of weathering and evaporation, as well as by application of individual clean-up techniques
- Prepare budgets for natural recovery, and for dispersant use at anticipated efficiency level

Smoke Plume Modeling

- Plume model available from National Institute of Standards and Technology (NIST) that can be used to estimate dispersion of the smoke from ISB (http://response.restoration.noaa.gov)
- Used to estimate downwind exposure concentrations
- Primary concern is for human health and safety
- There are standards available for exposure limits

Environmental Resources of Concern

- **Identify the scenario's geographic areas(s) of concern**
- **Identify the ecological communities and/or habitat types present in the area**
- **Identify characteristic or key species for each resource type**
- **Map the location, extent or prime use areas for each resource**
- **Obtain seasonal or life history information for important species**

Characteristics of Ecological Systems Relevant to oil spills

- Complex Linkages
- Density Dependence
- Keystone Species
- Time and Spatial Scaling
- Uncertainty and Variability
- Cumulative Effects
- Population versus Community Dynamics
- Definition of System Boundaries

Resources Assessment

Distribution Data

Population Data

Species of Special Concern

Resources of Concern

- Grouping of species/resources into categories (related species or habitats)
- Consideration of resources potentially affected by one stressor but not another
- Basis of value for resource (ecological/economic)
- Consider current status of species or population
- Exposure pathways affecting each resource, and
- Keeping the spill scenario/“what if” in mind.

Resources at Risk Matrix

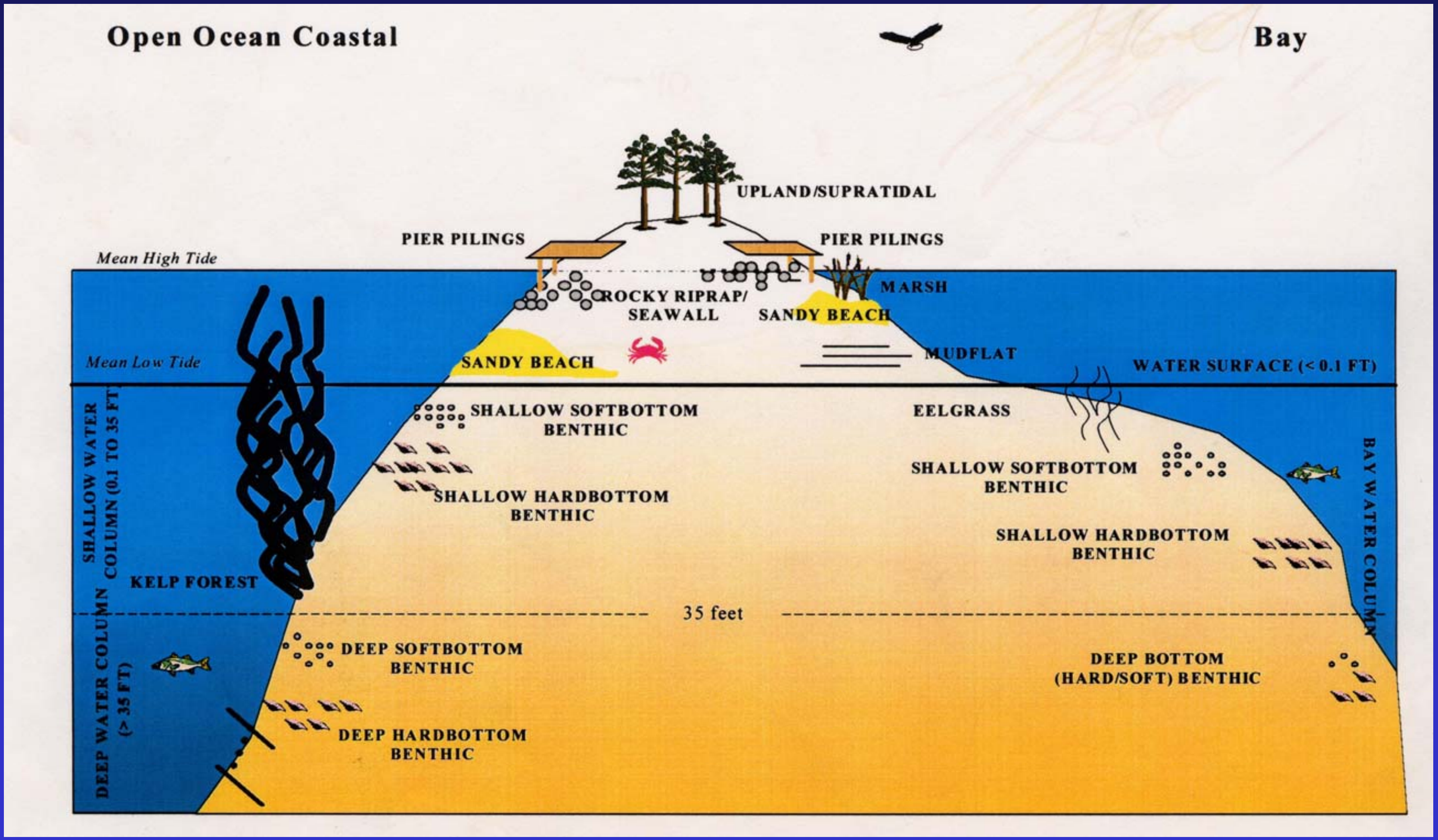
- •Terrestrial
- •Water Surface
- •Intertidal
  - •marshes, mudflats, sandy beaches, rip rap
- •Subtidal
  - •Benthic bay and coastal, kelp forest, eelgrass
- •Water Column

			Crustaceans	fiddler crabs
			Molluscs	snails
	Mud Flats		Vegetation	Gracilaria
			Birds	gulls; wading birds; shorebirds; waterfowl; canvasback
			Fish	sculpins; surf perch; topsmelt; flatfish
			Crustaceans	fiddler crabs; ghost shrimp
			Molluscs	clams
			Polychaetes	fat innkeepers; Nereis
	Sandy Beach		Mammals	raccoon; canids
			Birds	gulls; shore birds; snowy plover; sea ducks; raptors; loons; grebes
			Fish'	surf perch; surf smelt; striped bass
			Crustaceans	sand crabs; crabs
			Meiofauna	??
	Rocky/Rip Rap/Sea Walls		Vegetation	sea lettuce; leafy reds; corralines; sea palms; brown algae
			Mammals	harbor seals
			Birds	gulls; pelicans; shorebirds; alcids; oystercatcher
			Fish	sculpins; surf perch; rockfish; herring (and eggs)
			Crustaceans	crabs
			Molluscs	CA mussel; gastropods; abalone
			Epifauna	pile worms; feather dusters; tubeworms; sea urchins; starfish; anemones
	Pier Pilings		Vegetation	sea lettuce; leafy reds
			Birds	gulls; pelicans; cormorants
			Fish	sculpins; surf perch; rockfish; herring
			Crustaceans	crabs
			Molluscs	CA mussel; gastropods
			Epifauna	pile worms; feather dusters; tubeworms; sea urchins; starfish; anemones
Subtidal	Benthic Bay	Shallow Softbottom	Vegetation	Gracilaria
			Mammals	sea lions; harbor seals

Example Resource Classification Table

Habitat	Subhabitat	Resource Group	Example Species
Water Surface		Mammals	bottlenose dolphins, Risso's dolphins, Florida manatee
		Birds	northern gannet, black-legged kittiwake, sooty tern, common loon, pelicans, osprey
		Reptiles/Amphibians	green, loggerhead, Kemp's ridley sea turtles, American crocodile
Intertidal	Mangrove Forest	Vegetation	red, white and black mangrove, macroalgae
		Mammals	Florida manatee
		Birds	great blue heron, willets, American white pelican, cattle egret, roseate spoonbill, clapper rail
		Fish	bonefish, crevalle jack, mullet, sheepshead, killifish, snook, tarpon, seatrout, red drum, snapper
		Aquatic Arthropods	barnacles, amphipods, grass shrimp
		Mollusks	clams, oysters, mussels, snails
		Epifauna	algae, sponges, bryozoans

Ecosystems Identified for Use in Conceptual Model



General Goals/Response Objectives in Endpoint Definition

- Prevent or minimize taking of protected species
- Prevent or minimize degradation of water quality
- Prevent or minimize degradation of sensitive habitats, and
- Prevent or minimize the long-term disturbance of relative abundance and diversity of communities within habitats. (this is a “no net loss” statement for chronic effects)

Connecting Response Options to Resources

- **Develop an understanding about how the resources of concern can be affected by the response options (stressors)**
- **Based on concept of ‘hazards’**

Potential Environmental Risk and Exposure Pathways (Stressors)

- Air Pollution (evaporating oil and in-situ burning)
- Aqueous Exposure (inhalation or ingestion of whole oil droplets or dissolved components of the oil in the water column)
- Physical Trauma (mechanical impact from equipment, boats, etc)
- Physical Oiling/Smothering (due to direct contact)
- Thermal (heat exposure from ISB)
- Waste (exposure due to contact with waste generated by oil spill)
- Indirect (food web, ingestion of contaminated food, etc. . .)

Conceptual Model Matrix

Zones:	Terrestrial					Water Surface				Intertidal				
Habitats: / Sub-Habitats:	Upland and Supratidal									Marsh				
RESOURCES:	Vegetation	Mammals	Birds	Reptiles/Amphibians	Insects	Mammals	Birds	Reptiles/Amphibians	Vegetation	Mammals	Birds	Fish	Crustaceans	Mollusks
STRESSORS:														
Natural Recovery	7	1,7	1,7	1,7	1,7	1,4,7	1,4,7	1,4,7	2,4	1,4,7	1,4,7	2,7	2,4,7	2,4,7
On-Water Recovery	3	3,6	3,6	3,6	3,6	3	3	3	3	3	3	3	3	3
Shoreline cleanup	3,4,6	3,4,6	3,4,6	3,4,6	3,4,6	4,7	4,7	4	3,4	3,4	3,4	3,4	3,4	3,4
Oil + Dispersant	NA	NA	NA	NA	NA	7	7	NA	2	4,7	4,7	2,7	2,7	2,7
ISB	1	1	1	1	1	1,5	1,5	1,5	4,5	1,4,5,7	1,4,5,7	5,7	4,5,7	4,5,7

Note: On-water recovery includes protective and diversion booming
Note: N/A indicates that stressor and resource do not contact each other
These hazards represent changes from oil only scenario.
Shaded zones indicate areas of emphasis for the risk analysis

Hazards:

1. Air Pollution
2. Aqueous Exposure
3. Physical Trauma (mechanical impact from equipment, aircraft, people, boat bottoms, etc.)
4. Physical Oiling/Smothering
5. Thermal (heat exposure from ISB)
6. Waste
7. Indirect (food web, etc.)

Basic Conceptual Model

- Presented here as a matrix
- Natural Recovery (or a response option) is the **stresso**r
- Marine mammals (seals) are an affected **resource group**
- Oiling/Smothering is a **hazard affecting mammals**
- Rocky shorelines are a subhabitat where exposure occurs
- Entries for response options represent *changes from the natural recovery* (oil only) situation
- If the resource and the stressor are not connected through a hazard, there is no risk

Thresholds

- Threshold refers to a measurable level of exposure to a hazard that results in a definable level of effect in a resource of concern, i.e., the resource is susceptible
- For example, the amount of oil on a shoreline affects the degree of impact to plants
- **This is an important topic**!
- The entire group of workshop participants must discuss this issue before breaking into focus groups
- High potential to foster differences in opinion

To Be Affected, Resources Must be Susceptible

- Susceptibility has two components, **exposure** and **sensitivity**
- **Exposure** refers to co-occurrence, contact, or the absence of contact, depending on the nature of the stressor and the properties of the resource
- **Exposure** also has two components
  - duration
  - concentration
- **Sensitivity** refers to how readily a resource is affected by a particular stressor

Defining Thresholds

- Difficult to develop quantitative thresholds for oil spills
- Establish general goals for the analysis
- Identify general measures of environmental effects that are appropriate to the analysis
- Review available information on how the stressors may interact with your chosen environmental resources of concern
- Determine thresholds for concern to apply in the analysis

Examples of Possible Thresholds

- The proportion of organisms in a population potentially within the projected trajectory
- The amount of exposure leading to impaired reproductive potential of the resource
- The extent and duration of disturbance
- The extent of significant contamination relative to the total resource

Relationship between Hazards, Data and Possible Thresholds for Analysis

Hazard	Type of Data	General Threshold	Comments
Air Pollution	Concentration, distribution, and duration of model plume	Inhalation exposure of smoke particulates	Use human standards to estimate level of concern
Aquatic Toxicity	Concentration, distribution, and duration of total hydrocarbons in the water column	Toxicity table can be used to set thresholds (See Table 7-4)	Most quantitative of all information (also most confusing). Table of suggested thresholds is conservative
Physical Trauma	General area and length of time	Assume sensitive organisms can be harmed if in operating area	Generally not a critical factor, but it has been an issue in some spills (e.g. steam cleaning of rocks)
Oiling or Smothering	Surface area where slick could be located and density and duration of coverage. Linear extent of shoreline where slick might come ashore and rough estimate of amount of oil per unit of shoreline	Assume sensitive organisms can be harmed if in slick area or in area of oiled shoreline	Estimates are very imprecise. Assuming contact equals effects will overestimate concern. Must be interpreted with care, especially for shoreline
Thermal (ISB)	Area under the location of the burn	Loss of sensitive species	This is only important on shoreline if done improperly
Oil-Contaminated Waste Materials	Amount of waste likely to be generated (bbl) by shoreline cleanup	Compare to disposal or storage capacity	Not usually critical ecologically unless improperly done
Indirect	Persistence of exposure and the level of acute effect for species of concern	Estimate food chain effects from expected level of contamination. Estimate aquatic sublethal effects by comparing them with data on long-term exposure	Most sublethal and biochemical problems appear to be related to chronic exposure.

What Data is Available to Evaluate Specific Thresholds?

- Laboratory toxicity data
  - Acute
  - Chronic
- Data from field studies and related experiments
- Data from real spills

Final Thoughts on Thresholds

- Water column and sediment thresholds are easier to agree-on than floating surface oil and shoreline thresholds
- Conservative suggestions:
  - Water surface – contact with sheen
  - Shoreline – oiling by 10 to 100 grams per square meter
  - Water column and sediment – not as critical in non-dispersant situations, but threshold tables are available for review as needed

Determining the Level of Concern About Potential Effects

- Completing a risk matrix is the key to the analysis
- Develops numerical estimates of concern
  - by response option (stressor)
  - by resource
- The completed matrix allows:
  - comparison of impacts of each stressor individually
  - impact tradeoffs between stressors

Steps in the Risk-Ranking Process

- Develop the risk-ranking matrix
- Obtain consensus on scales for the risk-ranking matrix
- Agree on the Resources-at-Risk Table
- Develop preliminary risk scores using focus groups
- **Do the Natural Recovery option first**
  - **Basis for all future scores**
- Obtain a consensus on summary scores for each response option before moving on to the next
- Convert preliminary risk scores to summary scores

Risk Ranking (cont.)

- Allow focus groups to review and reconsider their initial risk scoring
- Review revised scores and develop consensus on final risk scores
  - Complete consensus is not necessary
  - Focus on significant differences
- Scores that cross summary categories and cannot be resolved indicate data gaps or issues of interpretation

What Is a Risk Ranking Matrix?

- **Each axis of the square represents a parameter used to describe risk**
- **X-axis rates “recovery” and ranges from “reversible” to “irreversible”**
- **Y-axis evaluates “magnitude” and ranges from “severe” to “trivial”**
- **Each cell is assigned an alphanumeric value to represent relative impact**
- **Exact size is up to you depending on the results of your discussion about scaling the matrix**

Ecological Risk Matrix Design

RECOVERY

MAGNITUDE	1. Irreversible	2. Reversible
A. Severe	1A	2A
B. Trivial	1B	2B

The Risk Square

		RECOVERY			
		> 7 years (SLOW) **(1)**	3 to 7 years **(2)**	1 to 3 years **(3)**	< 1 year (RAPID) **(4)**
% of RESOURCE	> 60% (LARGE) **(A)**	1A	2A	3A	4A
	40 to 60% **(B)**	1B	2B	3B	4B
	20 to 40% **(C)**	1C	2C	3C	4C
	5 to 20% **(D)**	1D	2D	3D	4D
	0 to 5% (SMALL) **(E)**	1E	2E	3E	4E

Figure 2. The proposed Risk Square.

Risk Matrix with Levels of Concern

Figure 5-20: Final definition of Levels of Concern.

		RECOVERY			
		> 7 years (SLOW) (1)	3 to 7 years (2)	1 to 3 years (3)	< 1 year (RAPID) (4)
% of RESOURCE	> 60% (LARGE) (A)	1A	2A	3A	4A
	40 to 60% (B)	1B	2B	3B	4B
	20 to 40% (C)	1C	2C	3C	4C
	5 to 20% (D)	1D	2D	3D	4D
	0 to 5% (SMALL) (E)	1E	2E	3E	4E

Legend: Dark gray cells represent a "high" level of concern, gray cells represent a "moderate" level of concern, and clear cells represent a "limited" level of concern.

What Does Developing the Matrix Do?

- Helps compare the hazard or threat to different resources
- Allows the identification of areas where impacts are not clearly defined
- Allows for the comparison of possible response options
- Helps manage expectations
- Helps define the likely consequences of the spill and response

When Risk-Ranking, each Focus Group must Record the Following:

- Essential assumptions behind the risk rating
- Consequences if these assumptions are incorrect
- The overall data adequacy for determining the risk rating
- Any recommendations for data collection that will improve the analysis

Sample Risk Ranking

- Brief review of risk ranking from a previous workshop
- Middle Chesapeake Bay (Maryland Eastern Shore)
- Initial goal was to examine use of dispersants in shallow waters
- Concern was prompted by consequences of recent pipeline rupture

Maryland Eastern Shore Risk Ranking Matrix

		RECOVERY			
		> 10 years (SLOW) (1)	5 to 10 years (2)	1 to 4 years (3)	< 1 year (RAPID) (4)
% of RESOURCE AFFECTED	> 50% (LARGE) (A)	1A	2A	3A	4A
	30 to 50% (B)	1B	2B	3B	4B
	10 to 30% (C)	1C	2C	3C	4C
	0 to 10% (SMALL) (D)	1D	2D	3D	4D

Legend: Red cells represent a “high” level of concern, yellow cells represent a “moderate” level of concern, and green cells represent a “limited” level of concern.

Partially Completed Risk Matrix for One Group

Habitats	Water Surface			Intertidal							Subtidal														Water Column						
Subhabitats				Mangrove Forest							Submerged Aquatic Vegetation								Coral Reef						Shallow Water (<20 feet)						
Response Options	Mammals	Birds	Reptiles/Amphibians	Vegetation	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Epifauna	Vegetation	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Epifauna	Reptiles/Amphibians	Fish	Aquatic Arthropods	Coelenterates	Mollusks	Plankton	Reptiles/Amphibians	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Plankton	Reptiles/Amphibians
Habitat Scaling																															
Natural Recovery	3B	2A	1A	1A	4C	2A	3D	3A	3D	3B																					
	2A			1A																											
Mechanical Recovery	3B	2A	1A	1A	4C	2A	3D	3A	3D	3A																					
	2A			2A																											
Dispersants	3D	2C	1C	2D	4C	2C	3C	3C	3C	3D																					
	2C			2D																											

Example Risk Matrix With Scores (for Three Focus Groups)

Response Options	Water Surface			Intertidal			Subtidal						Water Column		
				Mangrove Forest			Submerged Aquatic Vegetation			Coral Reef			Shallow Water (<20 feet)		
Natural Recovery	2A	2B	2A	1A	1A	1A	3C	3D	4C	3D	3D	3D	4D	4D	4D
Mechanical Recovery	2A	2C	2B	2A	1A	1A	3B	3C	4C	3C	3C	3C	4D	4D	4D
Dispersants	2C	2D	2C	2D	3D	3C	3D	3B	3C	3D	3C	3C	4C	4C	4C

Partially Completed Initial Risk Matrix for Three Groups

Habitats	Water Surface			Intertidal							Subtidal														Water Column						
Subhabitats				Mangrove Forest							Submerged Aquatic Vegetation								Coral Reef						Shallow Water (<20 feet)						
Resources	Mammals	Birds	Reptiles/Amphibians	Vegetation	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Epifauna	Vegetation	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Epifauna	Reptiles/Amphibians	Fish	Aquatic Arthropods	Coelenterates	Mollusks	Plankton	Reptiles/Amphibians	Mammals	Birds	Fish	Aquatic Arthropods	Mollusks	Plankton	Reptiles/Amphibians
1	L	R	L	L	R	R	L	L	L	L																					
	3B	2A	1A	1A	4C	2A	3D	3A	3D	3B																					
	2A			1A																											
2	L	L	L	L	L	L	L	L	L	L																					
	4D	2B	4D	1A	4D	2C	3D	3D	3D	3A																					
	2B			1A																											
3	R	R	R	L	R	R	R	L	L	L																					
	3D	3C	3D	1A	4D	2B	4D	3D	3C	3B																					
	3C			1A																											

Final Maryland Eastern Shore Risk Matrix

Response Options	Habitat Type																							
							Intertidal									Subtidal								
	Upland and Supratidal			Water Surface			Salt Marsh and Mudflats			Seawalls/Pilings/Riprap			Sandy Beach			Shallow (<10')			Deep (>10')			Submerged Aquatic Vegetation		
Natural Recovery																								
On Shore *In Situ* Burning																								
Dispersant Application (80%)														-	-									
On Shore Mechanical Recovery													+	-										
On Water Mechanical Recovery and Shoreline								-	-				+											

Legend: Red cells represent a "high" level of concern, yellow cells represent a "moderate" level of concern, and green cells represent a "limited" level of concern.

A Real Result - the Maryland Eastern Shore (Three Focus Groups)

Response Options	Upland and Supratidal			Water Surface			Intertidal									Subtidal								
							Salt Marsh and Mudflats			Seawalls/Pilings/Riprap			Sandy Beach			Shallow (<10')			Deep (>10')			Submerged Aquatic Vegetation		
Natural Recovery	3C	3C	3C	3A	3A	1A	3C	3B	3B	4D	4C	4D	3C	3B	3B	3C	4D	4D	4D	4D	4D	4D	3C	4D
On Shore *In Situ* Burning	4D	3C	3D	3A	3A	1A	4C	3C	4B	4D	4C	4D	3C	3B	3B	3C	4D	4D	4D	4D	4D	4D	3C	4D
Dispersant Application (80%)	3C	2D	3D	3D	3C	3C	3D	3B	3D	4D	4B	4D	3D	3C	3C	3C	4B	4C	4D	4D	4C	4D	4B	4C
On Shore Mechanical Recovery	3C	3C	3D	3A	3C	1A	2B	3C	3A	4C	4C	4D	3B	3C	3B	3C	4D	4D	4D	4D	4D	4C	3C	4D
On Water Mechanical Recovery and Shoreline Protection	3C	3C	3C	3A	3C	1A	3C	3C	3C	4D	4C	4D	3B	3B	3C	3C	4D	4D	4D	4D	4D	4D	3C	4D

Some of Their Basic Conclusions

- Planning and Process
  - Local area does not have resources to prepare detailed plans
  - Focus on education and information transfer
- Response Options
  - Marsh burning could be an important option
  - On-water recovery estimates are overly optimistic
  - Selective use of dispersants should be investigated further
  - Appropriate response options for marshes need more attention
- Information Needs
  - Some remaining questions on dispersant impacts in restricted waters
  - Need better modeling capability

How Participants Reached Their Conclusions

- Scenario
- Response options
- Hazards
- Conceptual approach based on risk matrix
- Fate and effect model results
- Resources at risk
- Thresholds
- Risk estimation
- Relative risk interpretation

NEBA Workshop Approach

- Focus groups
  - Time for Mixed Viewpoints to be articulated
  - 8 to 10 people ideal per focus group
  - Work independently and compare results periodically
- Designed to encourage participation and identify issues
- Multiple workshops are desirable, which allows for:
  - Data collection
  - Coordination
  - Reflection on the process

NEBA Process is an Education and a Planning-for-Decision-making Tool

- Cannot be completed in real time, i.e., during the heat of spill response operations
- Can form the basis for better, more rapid response decisions
  - Needs to be an ongoing process
  - Multiple scenarios
  - ‘What if’ discussions
  - Increases the ‘comfort zone’

Understanding and Explaining the Limits of the Analysis

- There is always an element of uncertainty in this type of analysis
- If this had been a large-scale, detailed risk analysis, it would be possible to develop some quantitative estimates of uncertainty for elements of the assessment
- Regardless, there will most likely be sources of error that cannot be clearly measured

Limits of the Analysis (cont.)

- The consensus process is very qualitative and largely based on expert opinion; therefore, the uncertainty cannot be quantified
- Still need to identify potential sources of error
- Determine what affect these inadequacies can have on your analysis
- Determine what kind of data could resolve critical uncertainties

Sources of Error

- Conceptual model formation
- Information and data
- Natural variability
- Mistakes by participants

Interpreting the Results - Lessons Learned

- Conclusions should represent consensus statements
- Compare options to Natural Recovery
- Compare options to each other
- Identify most beneficial options
- Identify unacceptable options based on increased risk
- Identify issues for further investigation

Keys to Success

- Appropriate participation by all stakeholders
- Participants must take the process seriously
- Evaluate the data or expert opinions objectively
- Apply the thresholds consistently
- Be objective when using the risk matrix
- Remember that you are dealing with levels of concern, not actual impacts

NEBA Workshops

- Provide training in a methodology for risk-based spill response planning
- Provide enhanced awareness of response capabilities and environmental protection issues
- Test a framework for area-wide response planning
- Improve local response planning options and encourage constructive dialogue

Summary and Conclusions

- The trade-offs associated with all response options must be thoroughly understood.
- The NEBA process is primarily a planning tool and, to the extent possible, should be utilized as a part of spill response planning and drill exercises.

Questions?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